SURVIVAL OF THE FITTEST—BEECH BARK DISEASE-RESISTANT BEECH WILL LEAVE MORE OFFSPRING

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Abstract
In fully stocked (unthinned) stands on the Monongahela National Forest (MNF), beech bark disease (BBD)-resistant (canker-free) beech trees have the potential to leave more offspring than BBD-susceptible (heavily cankered) trees. Trees susceptible to BBD were replaced by red spruce seedlings and saplings (plot 1) or had their place in the tree canopy filled in by the expanding crowns of cucumber magnolia (plot 1), black cherry (plot 2), or sugar maple (plot 3). It is possible that some of these stands were cutover long before BBD arrived and thus represent stands of stump sprout origin and not seed origin. If this were the case, there would be clonal groups and thus potential pockets of BBD resistance. There were more suckers within 1.5m of resistant trees than within the same distance of cankered trees and few or no suckers within 1.5m of dead beech. These dead trees (genes) had already lost out in the struggle for survival.

Introduction
Soon after the discovery of beech bark disease in West Virginia by Mielke et al. (1982), three populations of beech trees were selected for survival monitoring. Each population contained approximately 200 trees. Within 15 years, mortality attributed to BBD was approaching 50 percent. A small cluster of apparently resistant trees was also detected in one plot. Apparent resistance is being defined as an absence of both beech scale and any cankering. After almost 20 years of exposure to BBD, nine completely smooth-barked trees were found in the original cohorts. All "resistant" trees were found in one cohort. Thus, at least 1.5 percent of the MNF beech population would seem to be resistant based on this sample. However, the resistant trees are highly clustered. Additional resistant trees were found growing adjacent to the plot containing the nine resistant trees.

Methodology
Preliminary observations indicated that the root plate for most of the standing beech stems in theses plots was about 3m in diameter. Observations and some excavations supported the hypothesis that root sprouts within 1.5m of the root flare were attached to lateral roots of that tree. It was observed that where standing dead and resistant trees were adjacent to each other, the root plate halo of the dead tree was not invaded by sprouts from the adjacent tree. These observations supported the concept of a 3-m diameter root plate.

Measurements Taken

- Trees were classified as **resistant**, **standing dead**, or **heavily cankered**. (After 20 years of exposure to BBD there were almost no lightly cankered trees.)
- Root flare diameters were measured so that a 1.5-m radius from the pith could be computed.
- Number of sprouts per tree.
- Height of sprouts.
- Basal caliper (diameter) of sprouts.
- Presence or absence of beech scale.
- Presence or absence of the secondary scale ***Xylococculus betulae.***
- Presence or absence of ***Neonectria***.

Results

Summary of Results

	Resistant*	Cankered**	Dead***
Number of Trees	10	15	15
Number of Sprouts	240	51	28
Average Number of Sprouts	24.0	3.4	1.9
Average Diameter (cm)	2.2	1.6	2.6
Average Height (cm)	189	130	196

* Resistant = Scale & canker free = smooth bark

** Cankered = Heavily cankered

*** Dead = Standing dead

Discussion

In the struggle for life, there are winners and losers; some individuals pass their ***superior genes*** onto the next generation and the losers simply die out. In the case of BBD in West Virginia, the winners could be viewed as the (superior) resistant trees and losers as the dead and heavily cankered trees. However, as in all games of chance, not all losers are equal. In the case of BBD, dead trees are bigger losers than heavily cankered trees. ***Or are they?*** The data indicate that although dead trees may have slightly fewer sprouts associated with them, the sprouts will be taller and have a larger basal diameter. In the case of dying trees, they give up their growing space to their root sucker, which takes advantage of this growing space and puts on both radial and height growth until it, in turn, becomes attacked by scale insects. Ultimately, it will suffer the same fate as its parent tree. It is these sprouts associated with dead trees that would have produced the aftermath forest were it not for replacement of beech by sugar maple and black cherry. ***One way to easily cause a shift in the beech gene pool would be to cut all suckers within 1.5m of a BBD-killed beech.*** In the long run (provided there is no global warming), these sites will revert to red spruce. Prior to turn-of-the-century logging, these were red spruce sites.

In Charles Darwin's "Origin of Species," we find the following quote: ***"Everyone has heard that when an American forest is cut down a very different vegetation springs up; but it has been observed that ancient Indian ruins in the Southern United States, which must have formerly been cleared of trees, now display the same beautiful diversity and proportion of kinds as in the surrounding virgin forest."*** Darwin predicted the return of spruce (*sans* man's intervention).

Occasionally, a heavily cankered pole was observed adjacent to a dead beech tree in our survey. In this case, we are observing the kind of aftermath forest observed in New England, *sensu* Houston (1975), where the aftermath stand was as susceptible to attack as the first rotation. In New England, many of the more valued timber species had been logged and the defective beech was allowed to continue growing into the highly defective aftermath forest. On the MNF, the defective beech is being outcompeted by healthy sugar maple, aggressive black cherry, healthy cucumber magnolia, and encroaching red spruce saplings.

In total contrast, in a similar beech plot on the Allegheny National Forest (ANF) that had been thinned to almost pure beech at or before it fell behind the killing front, significantly fewer beech trees have died and residual

trees, which have now reached sawlog size, are cankered- frequently heavily cankered. This plot is the closest example of the classical aftermath forest to be found on the ANF. However, other stands on the killing front already heavy to beech might well become classical aftermath forest.

Although only a few of the cankered trees had beech scale, none of the resistant trees had any beech scale. The native, secondary scale (***Xylococculus betulae***) was found on 11 of 15 cankered trees, whereas two resistant trees had one ***Xylococculus*** scale each.

By combining the dead and cankered classes of beech, the trees can be grouped as winners and losers.

	Winners (Resistant)	**Losers (Cankered or Dead)**
Average Number of Sprouts	24.0	2.6
Average Diameter	2.2 cm	2.1
Average Height	189 cm	163

Thus, the case could be made that individual winners leave nine times as many sprouts as losers. In addition, winners (resistant trees), on average, had taller and larger-diameter sprouts. However, as with games of chance, there are many times more losers than winners, and although beech is dropping out of the canopy, it will have a presence in the understory for a long time, if not in perpetuity.

Avoidance of a classical aftermath forest would seem to be dependent upon the presence of other species that can outcompete American beech, which loses its ecological advantage when impacted by the additional stressor, BBD.

Summary

When beech is a component of a biologically diverse, healthy forest, BBD is a beech-specific stressor that causes the replacement of most beech by more fit species.

This dead beech tree with one heavily cankered root sprout growing within the root plate area is a loser in the struggle for survival. The adjacent sapling is one of the beech-replacing sugar maples. The blue tape marks the 3.0m-diameter root plate.

Heavily cankered (living) beech tree with one root sucker attached within 1.5m of the pith. The large adjacent tree is one of the canopy replacing sugar maple trees. The blue tape is at 1.5m from the pith. A previously BBD-killed, decaying beech is lying in the background.

A winner in the struggle for survival, this BBD-resistant beech tree shows some of the 41 sprouts growing within 1.5m of the pith. Sprouts are flagged in red.

The small percentage of resistant trees has the potential to produce nine times as many sprouts as susceptible trees. However, there are more susceptible trees than resistant trees, which produce a larger number of smaller and susceptible sprouts. Beech will not disappear from the forest; its role will change and the wildlife impacts of reduced mast will be important!

References

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